

# MEMORANDUM



**MWH**

175 West Jackson Boulevard  
Suite 1900  
Chicago, Illinois 60604  
Tel: (312) 831-3000  
Fax: (312) 831-3021

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**To:** Kevin Adler **Date:** April 3, 2008  
**From:** Peter Vagt  
**Subject:** Lower Aquifer Extraction System Construction Completion Report

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The purpose of this memorandum is to document the construction of the extraction system designed to capture the benzene plume detected in the lower aquifer in the vicinity of monitoring well MW53 and the tetrachloroethene detected in MW30.

## **I. Introduction**

Historically, benzene and chloroethane have been detected in the samples collected from lower aquifer monitoring wells MW09, ATMW4D, MW10C, and MW53. MW09 and ATMW4D were abandoned and replaced by MW09R and MW56, respectively. Recently, tetrachloroethene has been detected at variable and at times increasing concentrations in samples from lower aquifer well MW30.

Purging systems were installed in MW10C and MW56 to capture and treat impacted groundwater from the lower aquifer. These pumps were turned on in October 2002. Concentrations of benzene and chloroethane in samples collected from MW09R have been decreasing and therefore an extraction system has not been installed in that well.

This construction completion report documents the construction, maintenance, and monitoring requirements for the lower aquifer groundwater extraction system installed near MW53 and in MW30. The objective of the extraction system is to capture and treat the benzene plume identified in the deepest part of the lower aquifer near MW53, as well as the documented occurrence of tetrachloroethene in the middle of the lower aquifer near MW30. The extraction systems near MW53 and in MW30 were turned on in August 2007.

## **II. Background**

MWH began a lower aquifer investigation in 2004. The investigation consisted of three phases of work. Phase 1 of the investigation, completed in November 2004, was designed to identify the source(s) of benzene and chloroethane in the lower aquifer. However, complications encountered during the Phase 1 investigation made it clear that identifying

an original source(s) would be difficult and could result in cross contamination from the upper to lower aquifer. Therefore, Phase 2 of the investigation was developed to address the extent of benzene-impacted groundwater near MW53. The results of the Phase 2 investigation indicated that a plume of groundwater containing benzene approximately 225 feet wide exists near MW53. A pumping test was conducted to provide hydraulic data to design a system capable of capturing and treating the groundwater near MW53. Phase 2 was completed in November 2005. Construction of the pumping system began in July 2006. MWH completed the third phase of the lower aquifer groundwater investigation in July 2006. This phase involved the installation of two sentinel wells, MW58 and MW59, approximately 300 feet downgradient from MW53. These wells were installed with 10 foot screens situated at the bottom of the lower aquifer. They are screened across the same elevation as monitoring well MW53. Sampling results from these wells are used to monitor the effectiveness of the capture system installed near MW53.

Historically, tetrachloroethene has been detected at low but increasing concentrations in samples from MW30. Tetrachloroethene was detected as high as 11 micrograms per liter ( $\mu\text{g/l}$ ) in September 2006. MWH recommended installing in MW30, a low-rate pumping system, similar to those installed in MW10C and MW56, to capture the tetrachloroethene and prevent its migration off-site. The U.S. EPA approved the installation and the lower aquifer extraction system was augmented to include MW30.

The most likely source(s) of contamination in the lower aquifer is one of the six production wells which ACS constructed and used in the past. MWH properly abandoned these production wells in 1998; thus, removing these potential sources of contamination.

The existing monitoring well network augmented with the new sentinel wells downgradient of MW53 will provide adequate coverage to monitor the lower aquifer downgradient of the Site. The monitoring network will verify that contaminants in the lower aquifer are not migrating off-site to the North.

### **III. System Description**

The lower aquifer extraction system consists of six designated extraction points: LA-12, LA-13, LA-14, LA-15, MW53 and MW30. Pumps have initially been installed at all extraction points except LA-13 and LA-15. The pump in MW30 extracts groundwater at a rate of 2 gallons per minute (gpm), similar to that of MW10C and MW56. The system near MW53 is designed to extract groundwater at 10 gpm, typically from two wells pumping at 5 gpm each. The pumps remove the groundwater from the lower aquifer and convey it to the Groundwater Treatment Plant (GWTP). The extracted groundwater is collected into the Holding Tank, Tank T-2, at the GWTP and is treated through the GWTP's normal process.

#### **IV. Summary of Construction Activities**

##### **System Piping Installation**

Construction of the lower aquifer extraction system began in August 2006. However, heavy rain during the summer and fall of 2006 prevented completion of this work in 2006. The area became too muddy and difficult to mobilize equipment and personnel. At the time, approximately 70 percent of the conveyance piping was laid out and completed. Work was halted for the winter and resumed in spring of 2007. The installation of the conveyance piping was completed in June 2007. Photographs of the construction are in Appendix A attached hereto.

The piping network that connects the extraction wells to the GWTP consists of two-inch diameter double-walled, high-density polyethylene (HDPE) pipes. Individual branches to each of the six extraction wells merge into a two-inch diameter header pipe that conveys the extracted water to the GWTP.

The pipes were installed in six-inch wide trenches. The trenches are three feet below ground surface per Town of Griffith municipal code. The piping network was pressure tested and then, after pipeline integrity was demonstrated, the trenches were backfilled with native material.

##### **Wellhead Construction**

In June 2007, reinforced concrete pads were poured at the ground surface above each of the extraction wells. A fiberglass cabinet was installed on top of each of the six concrete pads. Each cabinet is 44 inch long by 44 inch wide by 24 inches high. The fiberglass cabinets contain the electrical control box, an AMCO flow meter and the aboveground appurtenances for the extraction wells and pumps. A new fiberglass cabinet and pump was also installed at MW10C to replace the existing cabinet and pump, which had deteriorated.

##### **Pump Installation**

Grundfos RediFlo2 Pumps were installed in LA-12, LA-14, MW53, and MW30 in June 2007. Each pump has a maximum flow rate of five gallons per minute (gpm). The Grundfos RediFlo2 Manual is attached in Appendix B.

##### **Electrical Components**

The electrical components for the system were installed in June 2007. Single-phase, 460-volt power is provided at a panel located near the main access road to the GWTP. The electrical line from the panel is encased in a PVC conduit buried three feet below ground surface, extending to each of the extraction wells. Transformers located at each extraction well convert the 460 volt power to 120 volt, single-phase power to operate the pumps. This 120 volt electrical line feeds the control panel and the control wiring for each pump.

In August of 2007, the construction of the Lower Aquifer extraction system was completed. The system began operation on August 13, 2007.

## **V. Planned Operation and Maintenance**

### **Operation**

The lower aquifer extraction system will operate continuously at a minimum of three wells. The pump in MW30 will operate continuously at 2 gpm. Pumping rates in two wells near MW53 will be maintained at 5 gpm each. This results in a total pumping rate from the lower aquifer of 12 gpm.

Initially, in August 2007, the extraction system near MW53 included active extraction at wells LA-14 and MW53. This system may switch extraction well locations from LA-14 and MW53 to LA-12, LA-13, or LA-15 if the extraction wells at LA-14 or MW53 are down for maintenance. Additional wells near MW53 could also be brought online if needed to ensure adequate capture of the groundwater.

Operation of the extraction system is interlocked with operation of the GWTP. The extraction system would shut down in the event of alarm conditions at the GWTP. Such shut down conditions include:

- High-high level alarm in tank T-2
- High level alarm in the GWTP floor sumps
- Shut down of the GWTP

### **Inspections**

Annual inspections of the extraction system will be conducted. These inspections will involve a visual walk through of the extraction system and a thorough examination of the condition of the wellheads and the electrical wiring. The inspection will also confirm that security features (locks, covers) are adequate. The extraction pumps will be removed annually to be cleaned, inspected and repaired.

### **Monitoring and Reporting**

The status of the lower aquifer extraction system will be reported in the semiannual Groundwater Monitoring Summary Reports. These reports will include pumping rates from individual wells and total volume of groundwater extracted from the lower aquifer.

## **ATTACHMENTS**

### **Figures**

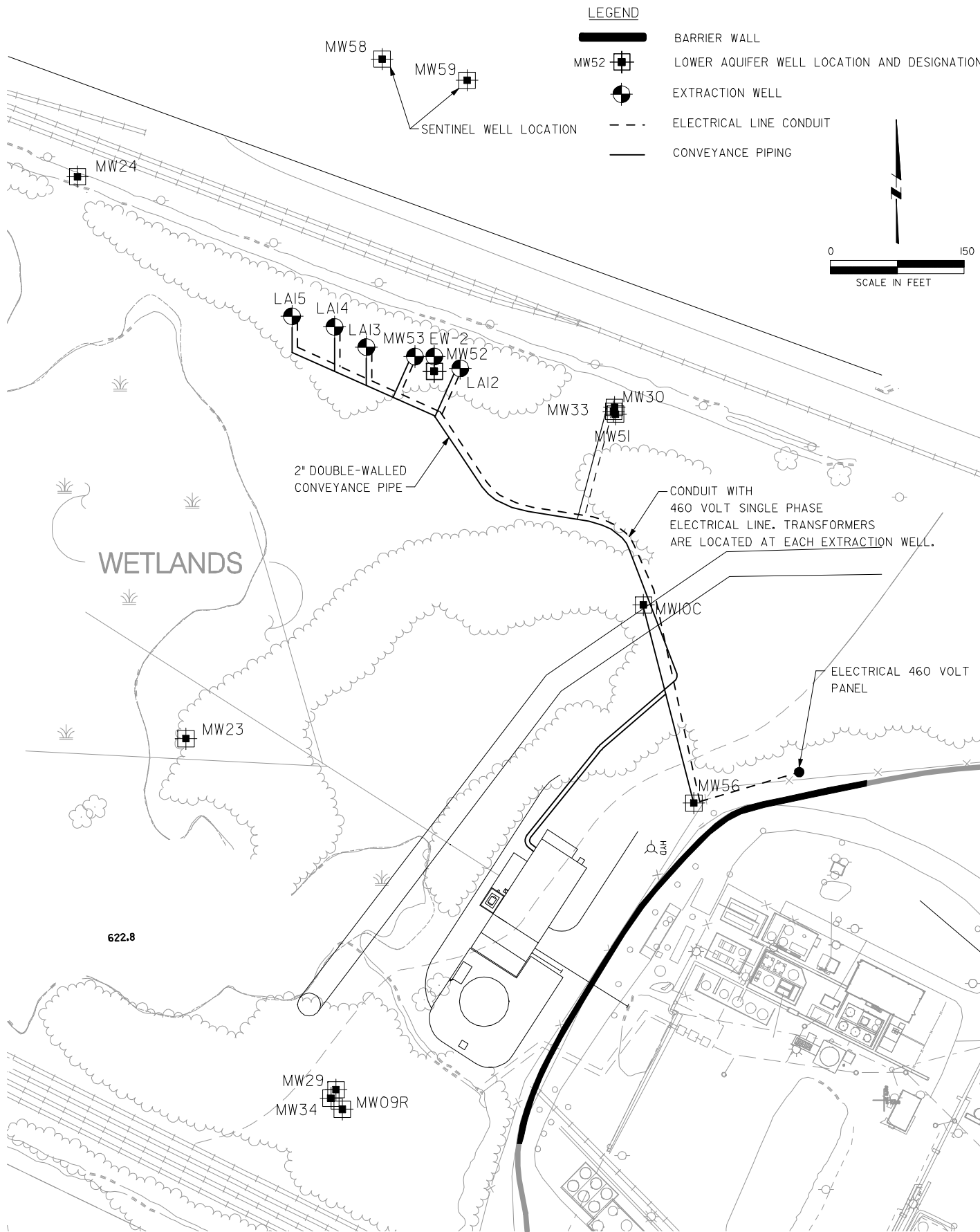
Figure 1 – Components of the Lower Aquifer Extraction System

Figure 2 – Lower Aquifer Pumping System Details

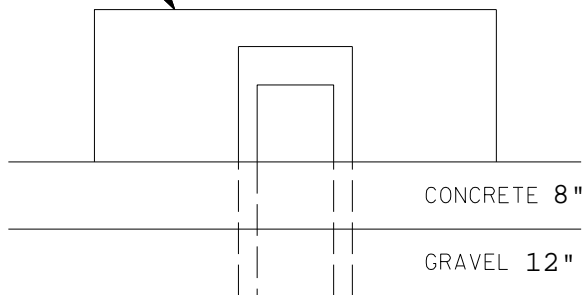
### **Appendices**

Appendix A – Photograph Log

Appendix B – Equipment Specifications



PUMP CONTROLLER AND  
ELECTRICAL SUPPLY WILL  
BE PLACED IN THE STEEL  
CABINET



CONCRETE 8"

GRAVEL 12"

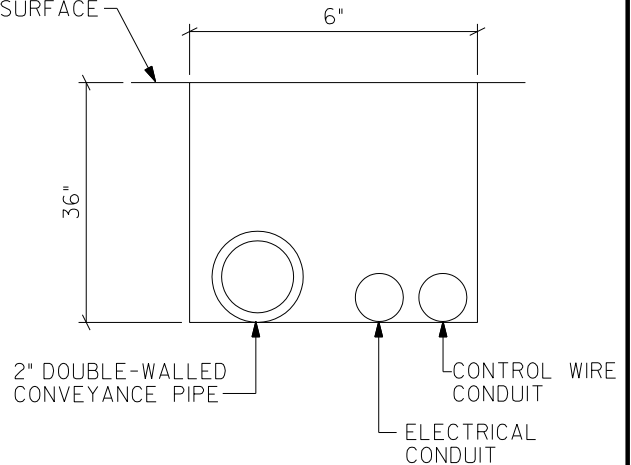
2" DOUBLE-WALLED  
CONVEYANCE PIPE

WELL CASING

2" PVC WELL  
WITH 0.010-INCH  
SLOT SCREEN

GRUNDFOS REDI-FL02  
EXTRACTION PUMP

EXISTING GROUND  
SURFACE



SECTION 2  
TYPICAL PIPE TRENCH

WELL ID	DEPTH OF WELL (FT BGS)	SCREEN INTERVAL (FT BGS)
LA-I2	85.3	75-85
LA-I3	85.3	75-85
LA-I4	82.3	72-82
MW53	86.0	76-86

SECTION 1  
LOWER AQUIFER WELL WITH EXTRACTION PUMP

NOT TO SCALE



AMERICAN CHEMICAL SERVICE, INC.  
NPL SITE  
GRIFFITH, INDIANA

LOWER AQUIFER PUMPING SYSTEM  
DETAILS

FIGURE

2

**APPENDIX A**  
**PHOTOGRAPH LOG**



Photograph #1: View of trench construction for installation of water conveyance pipe and electrical conduit.



Photograph #2: View of trench for water conveyance pipe and electrical conduit. This photo shows the wet soil conditions present at the work area.





Photograph #3: View of trench for electrical conduit near the treatment plant.



Photograph #4: View of the wellhead box for MW30. The electrical transformer for the wellhead is on the left side. All wellhead boxes are furnished with locks.



Photograph #5: View of the interior wellhead box for MW30.

## **APPENDIX B**

### **EQUIPMENT SPECIFICATIONS**

# Redi-Flo Variable Frequency Drive

**(USA)** Installation and operating instructions

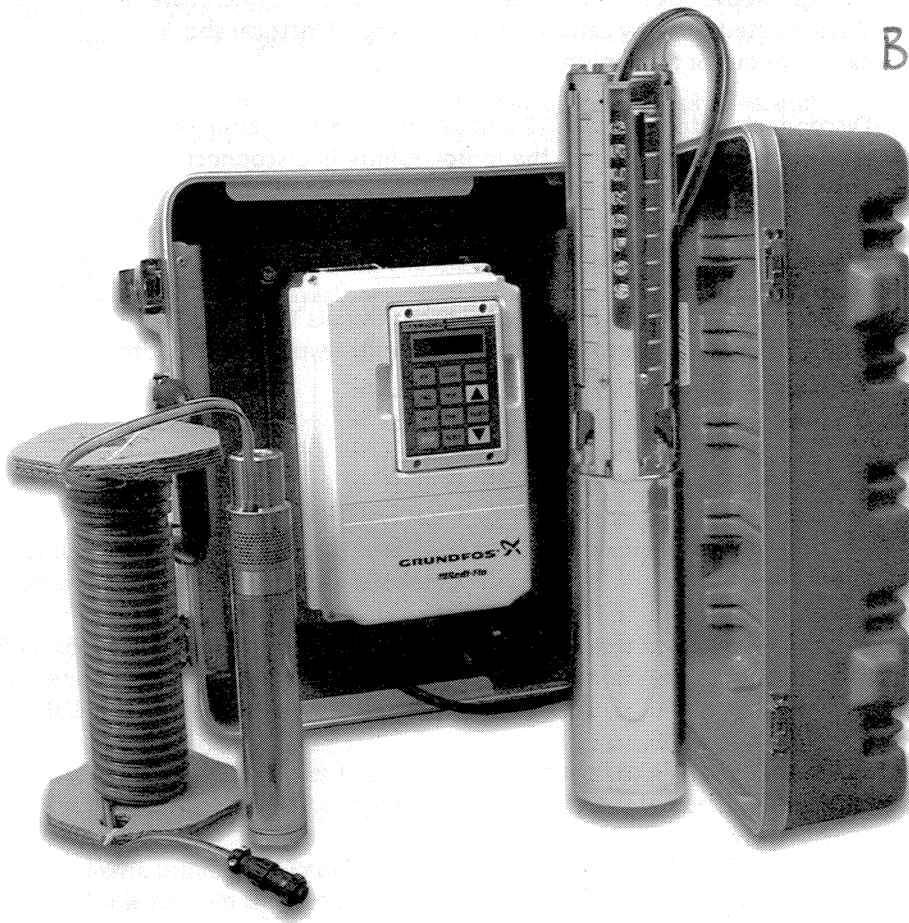
REDI-FLO Z  
SUPPLIER USA BLUE  
BOOK

1-800-548-1234

VFD STOCK# 67692

BADGER 1"  
Flow  
METER

STOCK# 62280



## SAFETY NOTICE

This equipment contains voltages that may be as great as 1000 volts! Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt the start-up procedure or troubleshoot this equipment.

### PRECAUTIONS:



**WARNING:**

Do not touch any circuit board, power device or electrical connection before you first ensure that power has been disconnected and there is no high voltage present from this equipment or other equipment to which it is connected. Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt the start-up procedure or troubleshoot this equipment.



**WARNING:**

Be sure the system is properly grounded before applying power. Do not apply AC power before you ensure that grounds are connected. Electrical shock can cause serious or fatal injury.



**WARNING:**

Do not remove cover for at least five (5) minutes after AC power is disconnected to allow capacitors to discharge. Electrical shock can cause serious or fatal injury.



**CAUTION:**

Disconnect motor leads (T1, T2 and T3) from control before you perform a "Megger" test on the motor. Failure to disconnect motor from the control will result in extensive damage to the control. The control is tested at the factory for high voltage / leakage resistance as part of Underwriter Laboratory requirements.



**CAUTION:**

Do not connect AC power to the Motor terminals T1, T2 and T3. Connecting AC power to these terminals may result in damage to the control.



## QUICK START GUIDE

To operate the Redi-Flo VFD system, simply:

1. Submerge the RF2 or RF4 pump in the water to be pumped.
2. Connect the motor lead to the Redi-Flo VFD. (Note: With RF4 Variable Performance Pumps you must have an adapter cord to connect to Redi-Flo VFD.

**#3 and #4 for operation with generator only.**

**WARNING: Do not let the generator run out of gas while powering the VFD. If it surges and creates excessive voltage, internal VFD damage could result.**

3. If using a generator, start the generator and allow it to warm up.
4. If the generator has a circuit breaker, close the breaker and check the output voltage from the generator. The output voltage must be within the specified ranges (refer to Technical Specifications, at the end of this manual) to ensure proper operation and prevent damage to the system. If the voltage is too high or too low, adjustments to the generator must be performed to allow the system to run.
5. Plug the Redi-Flo VFD into a generator or connect to utility power supply. The unit accepts 115V or 230V sources. Refer to the Input Power Terminals section for wiring instructions.

**WARNING: Incorrect wiring on the 115V or 230V terminals will damage the drive.**

6. The VFD will initialize and be ready to drive the motor. After the initialization screen appears, the following will be displayed:

STP	0V	REDIFL2
LOC	0.0A	0.00HZ

- STP means the drive is stopped
- V indicates motor volts
- REDIFL2 indicates Redi-Flo2 pump mode
- LOC means the drive is in Local Keypad Mode
- A indicates motor amps
- HZ indicates motor frequency

The VFD defaults to Redi-Flo2 operation. To change to Redi-Flo4 press the sequence SHIFT-▼-SHIFT keys. Use sequence SHIFT-▲-SHIFT to return to Redi-Flo2.

7. Press the FWD key to start the motor and use the ▲ and ▼ arrow keys to increase or decrease speed. Continuous holding of the arrow key will increase the rate of speed change. The STOP key is used to stop the motor.
8. Pressing the ENTER key allows the user to quickly set the speed to any given value by using the ▲ and ▼ arrows to change speed and the SHIFT key to cursor between digits.
9. When powering down, unplug the Redi-Flo VFD from the generator BEFORE removing the motor lead from the Redi-Flo VFD or turning off the generator.

**Note: To prevent tripping power source circuit breakers please observe the following: When using the Redi-Flo4 pump and a VFD power source of 115VAC, motor speeds of greater than 70Hz may draw over 15 amps. For 230VAC power source motor speeds greater than 90 Hz may draw over 15 amps. In RediFlo4 mode, 100 Hz cannot be exceeded without changing parameters.**

# PRE-INSTALLATION CHECKLIST

## Components of Your Redi-Flo VFD System

Your Redi-Flo Variable Performance Pump system should contain the following components:

1. Redi-Flo Variable Frequency Drive, (See Figure 1)
2. Either a Redi-Flo2® pump and motor with lead (Figure 2) or a Redi-Flo4™ Variable Performance pump, motor, lead, lead/plug and RF4 x VFD adapter cord (Figure 3).

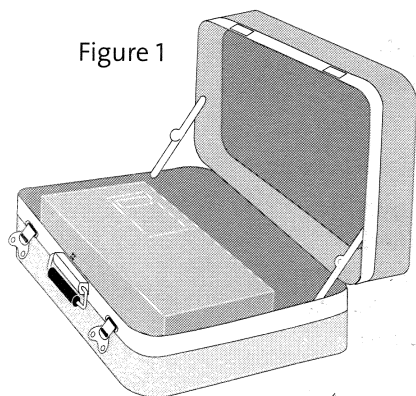


Figure 1



Redi-Flo2®

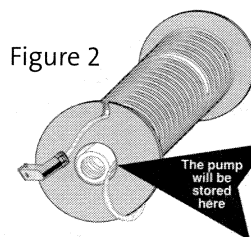


Figure 2

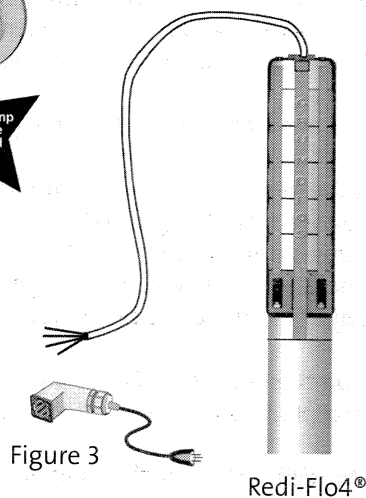


Figure 3

Redi-Flo4®

## To operate the system you will also need:

1. A discharge hose or pipe to connect to the pump (See Figure 4).
2. An electrical plug to connect the Redi-Flo VFD power cord to your portable generator may be needed if the supplied plug is not compatible with your generator (See Figure 5).
3. Safety cable and hardware for lowering and lifting the pump (See Figure 6).

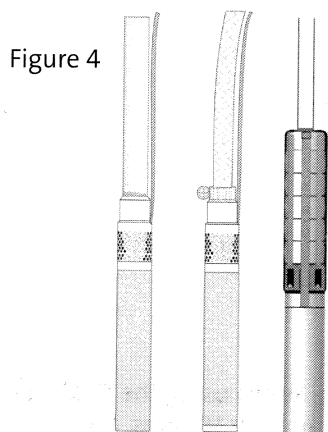


Figure 4

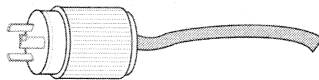


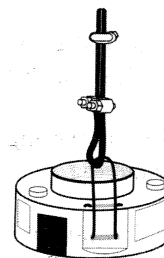
Figure 5

The exact type of plug used will depend upon your generator. The Redi-Flo VFD is supplied with a standard NEMA 5-15P, 115V, 3 prong plug.



Redi-Flo2®

Figure 6



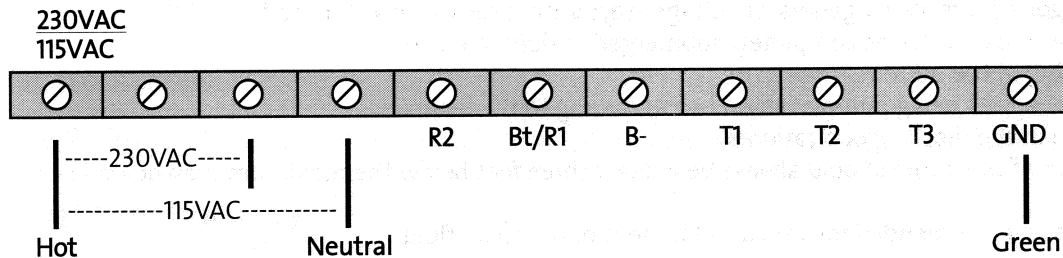
Redi-Flo4®

# ASSEMBLING THE REDI-FLO VFD SYSTEM

## INPUT POWER TERMINALS

The input voltage can be changed between 115V and 230V by changing the line input connections as shown below:

**Warning - If the Redi-Flo VFD is miswired for the incoming voltage, internal damage may occur to the drive.**



## Attaching the Pump to the pipe

When connecting the discharge pipe or tubing to the pump, a back-up wrench should be used. It is recommended that a safety cable be attached to the pump (using special brackets and cables, sold separately) anytime plastic pipe or flexible tubing is used (as shown in figure 6). A check valve may also be added to Redi-Flo2® pumps to prevent fluid from flowing back into the pump after it is turned off (backflow prevention). A check valve is standard on Redi-Flo4™ pumps. Always check to ensure joints are fastened securely. The use of a torque arrestor is not required when using the Redi-Flo VFD.

## Lowering the Pump Into the Well

Make sure the electrical motor leads are not cut or damaged in any way when the pump is being lowered into the well. Do not use the motor leads to support the weight of the pump. To protect against surface water entering the well and contaminating the well, the well should be finished off utilizing a locally approved well seal.

The motor lead should be secured to the discharge pipe or tubing at frequent intervals to prevent sagging, looping and possible motor lead damage. Teflon® wire ties are recommended for environmental applications.

### IMPORTANT

Plastic pipe and tubing tend to stretch under load. This stretching must be taken into account when securing the motor lead to the riser pipe or tubing. Leave three to four inches of slack between clipped points. This tendency to stretch will also affect the calculation of the pump setting depth. When plastic pipe or tubing is used, it is recommended that a safety cable be attached to the pump to raise and lower it. Redi-Flo4™ pumps are designed to accommodate this cable and Redi-Flo2® pumps can be fitted with a safety cable bracket (part number 1A0019).



# ASSEMBLING THE REDI-FLO VFD SYSTEM

## OPERATING CONDITIONS

To ensure the Redi-Flo Variable Performance Pumping system operates properly, follow these guidelines:

- The Redi-Flo2® or Redi-Flo4™ pump must be installed vertically with the discharge end pointed upwards.
- The electrical voltage supply to the Redi-Flo VFD must always be within + or - 10% of the specified power supply ( 103.5 - 126.5 VAC at 115V connection or 207 - 253 VAC at 230V ).
- For best performance when operating on a generator, 115V generators should be set at 120V without load and 230V generators should be set at 240V without load. Use a separate meter to set voltage; do not rely on built-in meters found on generators. Verify generator voltage stays within tolerance at full load.
- The pump and motor must always be completely submerged in fluid to ensure lubrication and cooling of the motor.
- The temperature of the fluid being pumped should be according to the technical specifications shown in the motor specifications.
- The installation depth of the pump should always be at least three feet below the maximum drawdown level of the well.
- Redi-Flo pumps are not recommended for well development or pumping fluid containing abrasives.
- Redi-Flo2® pumps are not recommended for continuous operation applications.
- The warranty of the Redi-Flo pumps will be void if other than the Redi-Flo VFD is used or if corrosive fluids are pumped.
- The service life of dedicated Redi-Flo pumps may be compromised if the ambient water quality exceeds one or more of the following values:

pH<5   DO>2 ppm   H2S>1 ppm   CL->500 ppm   TDS>1000 ppm

## Adherence To Environmental Regulations

When handling and operating the Redi-Flo Variable Performance Pump system, all environmental regulations concerning the handling of hazardous materials must be observed. When the pump is taken out of operation, great care should be taken to ensure that the pump contains no hazardous materials that might cause injury to human health or to the environment.

## Purging A Well

If the pump is used to purge a well, start the pump at minimum speed and gradually increase to desired speed. Redi-Flo products are not recommended for well development.

## Generator Usage

### Minimum generator size

For generators with voltage regulation  
For generators without voltage regulation  
Recommended for optimal performance

### (Redi-Flo2/Redi-Flo4)

2500/3400 watts at 115/230VAC, single phase  
5000/6700 watts at 115/230VAC, single phase  
4000/5400 watts at 115/230 VAC, single phase  
with voltage regulation

### Dual Input Capability

Redi-Flo VFD can accept 115V or 230V single phase input voltage. Refer to the input power terminal section on page 4 for connection instructions.

### Enclosure

The Redi-Flo VFD NEMA 4 enclosure is designed for outdoor duty and is resistant to damage as a result of incidental exposure to rain.

### UL Approvals

The Redi-Flo VFD is UL Listed to U.S. and Canadian electrical safety standards.

### Dual Functionality

The Redi-Flo VFD can change from operating Redi-Flo2® (MP1) to Redi-Flo4™ Variable Performance pumps with a few keystrokes.

### Optimized Volts/Frequency (V/Hz) Pattern

The Redi-Flo VFD V/Hz pattern is specially optimized to allow the most efficient operation of Redi-Flo2® and Redi-Flo4™ variable performance pumps.

# REDI-FLO VFD KEYPAD OVERVIEW

## Overview

The keypad is used to program the control parameters, to operate the motor and to monitor the status and outputs of the control by accessing the display options, diagnostic menus and the fault log.



### Indicator Lights

- JOG - (Green) lights when Jog is active.
- FWD - (Green) lights when FWD direction is commanded.
- REV - (Green) lights when REV direction is commanded.
- STOP - (Red) lights when motor STOP is commanded.

**Motor Selection** - The VFD defaults to Redi-Flo2 operation, to change to Redi-Flo 4, press the key sequence "Shift - ▼ - Shift." Use the sequence "Shift - ▲ - Shift" to return to Redi-Flo2.

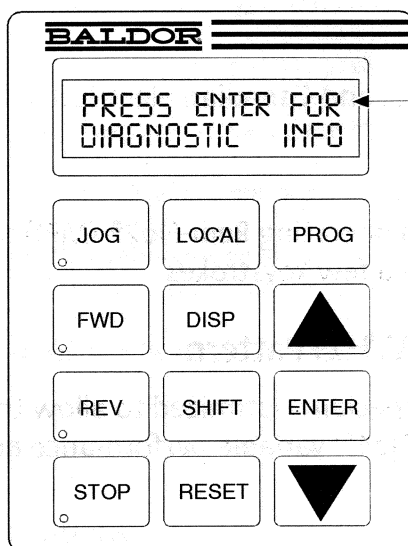
**JOG** - Press JOG to select the preprogrammed jog speed. After the jog key has been pressed, use the FWD or REV keys to run the motor in the direction that is needed. The JOG key is only active in the local mode.

**FWD** - Press FWD to initiate forward rotation of the motor. (Active in Local and Jog modes).

**REV** - Press REV to initiate reverse rotation of the motor. (Active in Local and Jog modes).

**STOP** - Press STOP to initiate a stop sequence. Depending on the setup of the control, the motor will either regen or coast to a stop. This key is operational in all modes of operation unless it has been disabled by the Keypad Stop parameter in the Keypad (programming) Setup Block.

**LOCAL** - Press LOCAL to change between the local (keypad) and remote operation.



**DISP** - Press DISP to return to display mode from programming mode. Provides operational status and advances to the next display menu item.

**SHIFT** - Press SHIFT in the program mode to control cursor movement. Pressing the SHIFT key once moves the blinking cursor one character position to the right. While in program mode, a parameter value may be reset to the factory preset value by pressing the SHIFT key until the arrow symbols at the far left of the keypad display are flashing, then press an arrow key. In the display mode the SHIFT key is used to adjust the keypad contrast.

**RESET** - Press RESET to clear all fault messages (in local mode). Can also be used to return to the top of the block programming menu without saving any parameter value changes.

**Keypad Display** - Displays status information during Local or Remote operation. It also displays information during parameter setup and fault or Diagnostic Information.

**PROG** - Press PROG to enter the program mode. While in the program mode the PROG key is used to edit a parameter setting.

### ▲ (UP Arrow)

Press ▲ to change the value of the parameter being displayed. Pressing ▲ increments the value to the next greater value. Also, when the fault log or parameter list is displayed, the ▲ key will scroll upward through the list. In the local mode pressing the ▲ key will increase motor speed to the next greater value.

**ENTER** - Press ENTER to save parameter value changes and move back to the previous level in the programming menu. In the display mode the ENTER key is used to directly set the local speed reference. It is also used to select other operations when prompted by the keypad display.

### ▼ (DOWN Arrow)

Press ▼ to change the value of the parameter being displayed. Pressing ▼ decrements the value to the next lesser value. Also, when the fault log or parameter list is displayed, the ▼ key will scroll downward through the list. In the local mode pressing the ▼ key will decrease motor speed to the next lesser value.

# MOTOR CONTROL VIA KEYPAD

The Redi-Flo VFD can operate the motor in three (3) different ways from the keypad.

1. Speed adjustment using the Keypad arrow keys
2. Speed adjustment with Keypad entered values
3. JOG Command

## 1) Keypad arrow speed control

Press FWD or REV to select desired direction of motor rotation, then press or hold the up arrow key ▲ to increase speed or use the down arrow key ▼ to reduce motor speed. Continuously holding the arrow key will cause the speed to change in larger increments. The minimum speed increment produced by the arrow keys is defined in PROG/Keypad Setup/Keypad Speed INC. Default value of 0.10 Hz can be changed by the user.

## 2) Keypad speed entered value

Press the ENTER key and use the ▲ and ▼ arrow keys to adjust digits and the SHIFT key to cursor to the desired digit. Press ENTER when finished selecting desired motor speed to return to the display mode. Press the FWD or REV key to run the motor in the desired direction at the programmed speed.

## 3) JOG Command

The JOG key can be used to ramp the pump up to a predetermined speed in the forward or reverse direction. Press the JOG key then hold the FWD or REV key, and the pump will ramp to the speed set in PROG/Jog Settings/Jog Speed. Acceleration and deceleration times for Jog can also be set in this programming menu.

## DISP Key

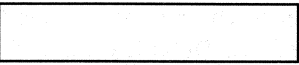
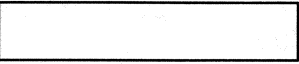
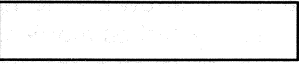

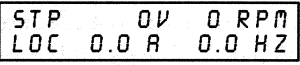
The DISP key can be used for accessing diagnostic and troubleshooting screens as shown below:

Action	Description	Display	Comments
Apply Power	Display mode showing mode, voltage, current & frequency status.	STP 0V REDIFL2 LOC 0.0 A 0.0 HZ	No faults present. Local keypad mode. If in remote mode, press local for this display.
Press DISP key	Scroll to fault log block.	PRESS ENTER FOR FAULT LOG	Press ENTER to view the fault log if desired.
Press DISP key	Scroll to diagnostic info block.	PRESS ENTER FOR DIAGNOSTIC INFO	Press ENTER to view diagnostic information if desired.
Press DISP key	Scroll to local speed ref. block.	PRESS ENTER FOR LOCAL SPEED REF	Press ENTER to change motor speed.
Press DISP key	Display mode showing output frequency.	STOP FREQUENCY LOCAL 0.00 HZ	
Press DISP key	Display mode showing motor speed (based on output frequency).	STOP MOTOR SPEED LOCAL 0 RPM	
Press DISP key	Display mode showing output current.	STOP CURRENT OUT LOCAL 0.00 A	
Press DISP key	Display mode showing output voltage.	STOP VOLTAGE OUT LOCAL 0 V	

## MOTOR CONTROL VIA KEYPAD

### Adjusting Display Contrast

When AC power is applied to the VFD, the keypad should display the status of the unit. If there is no display visible, or if it is difficult to read, use the following procedure to adjust the display. Contrast may be adjusted in the display mode when motor is stopped or running.

Action	Description	Display	Comments
Apply Power	No visible display		Display mode.
Press DISP Key	Places control in display mode		
Press SHIFT key 2 times	Allows display contrast adjustment		
Press ▲ or ▼ Key	Adjusts display intensity		
Press ENTER	Saves level of contrast and exits to display mode		

## Advanced Programming

A password is required for advanced programming features. **Altering some default settings for Redi-Flo2 or Redi-Flo4 could possibly damage the motor or VFD.** For additional programming instructions, please refer to the full programming guide found at the Baldor website: [www.Baldor.com](http://www.Baldor.com) The manual can be found under Support — installation and operation manuals. It is Baldor manual number MN715, Series 15H Inverter.

LEVEL 1 BLOCKS		LEVEL 2 BLOCKS	
<b>Preset Speeds</b>	<b>Input</b>	<b>Output Limits</b>	<b>Brake Adjust</b>
Preset Speed #1	Operating Mode	Operating Zone	Resistor Ohms
Preset Speed #2	Command Select	Min Output Frequency	Resistor Watts
Preset Speed #3	ANA CMD Inverse	Max Output Frequency	DC Brake Voltage
Preset Speed #4	ANA CMD Offset	PK Current Limit	DC Brake Frequency
Preset Speed #5	ANA CMD Gain	REGEN Limit	Brake on Stop
Preset Speed #6	CMD SEL Filter	REGEN Limit ADJ	Brake on Reverse
Preset Speed #7	Power Up Mode	PWM Frequency	Stop Brake Time
Preset Speed #8			Brake on Start
Preset Speed #9	<b>Output</b>	<b>Custom Units</b>	Start Brake Time
Preset Speed #10	Digital Out #1	MAX Decimal Places	
Preset Speed #11	Digital Out #2	Value at Speed	<b>Process Control</b>
Preset Speed #12	Digital Out #3	Value DEC Places	Process Feedback
Preset Speed #13	Digital Out #4	Value Speed REF	Process Inverse
Preset Speed #14	Zero SPD Set PT	Units of Measure	Setpoint Source
Preset Speed #15	At Speed Band	Units of MEAS 2	Setpoint Command
	Set Speed Point		Set PT ADJ Limit
<b>Accel / Decel Rate</b>	Analog Out #1	<b>Protection</b>	At Setpoint Band
Accel Time #1	Analog Out #2	External Trip	Process PROP Gain
Decel Time #1	Analog Scale #1	Local Enable INP	Process INT Gain
S-Curve #1	Analog Scale #2		Process DIFF Gain
Accel Time #2	Underload Set Point		Follow I:O Ratio
Decel Time #2			Follow I:O Out
S-Curve #2	<b>V/HZ and Boost</b>	<b>Miscellaneous</b>	Encoder Lines
	Ctrl Base Frequency	Restart Auto/Man	Integrator Clamp
<b>Jog Settings</b>	Torque Boost	Restart Fault/Hr	Minimum Speed
Jog Speed	Dynamic Boost	Restart Delay	
Jog Accel Time	Slip Comp Adj	Factory Settings	
Jog Decel Time	V/HZ Profile	Language Select	
Jog S-Curve	V/HZ 3-PT Volts	STABIL ADJ Limit	
	V/HZ 3-PT Frequency	Stability Gain	
<b>Keypad Setup</b>	Max Output Volts	<b>Security Control</b>	<b>Skip Frequency</b>
Keypad Stop Key		Security State	Skip Frequency #1
Keypad Stop Mode		Access Timeout	Skip Band #1
Keypad Run Fwd		Access Code	Skip Frequency #2
Keypad Run Rev			Skip Band #2
Keypad Jog Fwd			Skip Frequency #3
Keypad Jog Rev			Skip Band #3
3 Speed Ramp			
Switch on Fly			
LOC. Hot Start			
		<b>Motor Data</b>	<b>Synchro Starts</b>
		Motor Voltage	Synchro Starts
		Motor Rated Amps	Sync Start Frequency
		Motor Rated Speed	Sync Scan V/F
		Motor Rated Frequency	Sync Setup Time
		Motor Mag Amps	Sync Scan Time
			Sync V/F Recover
			Sync Direction
			<b>Communications</b>
			Protocol
			Baud Rate
			Drive Address

# TROUBLESHOOTING GUIDE TO ERROR MESSAGES

INDICATION	POSSIBLE CAUSE	CORRECTIVE ACTION
Command Select	Incorrect operating mode programmed.	Change Operating Mode in the Level 1 Input block to one that does not require the expansion board.
	Need expansion board.	Install the correct expansion board for selected operating mode.
Bus Overvoltage Trip or HW Overvoltage	DECEL Rate set too low a value	Lengthen DECEL time. Add external dynamic braking resistors or module.
	Input voltage too high.	Verify proper AC line voltage. Use step down transformer if needed. Use line reactor to minimize spikes.
Bus Undervoltage	Input voltage too low.	Verify proper AC line voltage. Use step up transformer if needed. Check power line disturbances (sags caused by start up of other equipment). Monitor power line fluctuations with date and time imprint to isolate power problem.
External Trip	Motor draws excessive current.	Check motor for overloading. Verify proper sizing of control and motor.
	External trip parameter incorrect.	Verify connection of external trip circuit at J4-16. Set external trip parameter to "OFF" if no connection made at J4-16.
Hardware Protect	Fault duration too short to be identified.	Reset control. Check for proper grounding of power wiring and shielding of signal wiring. Replace control board.
Heatsink Temp	Motor Overloaded.	Correct motor loading. Verify proper sizing of control and motor.
	Ambient temperature too high.	Relocate control to cooler operating area. Add cooling fans or air conditioner to control cabinet.
	Built-in fans are ineffective or inoperative.	Verify fan operation. Remove debris from fan and heatsink surfaces. Replace fan or check fan wiring.

## TROUBLE SHOOTING GUIDE (CONT.)

INDICATION	POSSIBLE CAUSE	CORRECTIVE ACTION
HW Desaturation	Accel/Decel rate set too short. Torque Boost set too high. Electrical noise in logic circuits. Motor overloaded.	Lengthen Accel/Decel rate. Reduce torque boost value. Check for proper grounding of power wiring and shielding of signal wiring. Verify proper sizing of control and motor or reduce motor load.
HW Power Supply	Power supply malfunctioned.	Check internal connections. Replace logic power board.
HW Ground Fault	Output current (motor current) leakage to ground.	Disconnect wiring between control and motor. Retry test. If GND FLT is cleared, reconnect motor leads and retry the test. Repair motor if internally shorted. Replace motor lead wire with low capacitance cable. If GND FLT remains, contact your dealer.
Motor Will Not Start	Motor overloaded.	Check for proper motor loading. Check couplings for binding. Verify proper sizing of control and motor.
	Motor may be commanded to run below minimum frequency setting.	Increase speed command or lower minimum frequency setting.
	Incorrect Command Select parameter.	Change Command Select parameter to match wiring at J4.
	Incorrect frequency command.	Verify control is receiving proper command signal at J4.
Motor Will Not Reach Maximum Speed	Max Frequency Limit set too low.	Adjust Max Frequency Limit parameter value.
	Motor overloaded.	Check for mechanical overload. If unloaded motor shaft does not rotate freely, check motor bearings.
	Improper speed command.	Verify control is receiving proper command signal at input terminals. Verify control is set to proper operating mode to receive your speed command.
Motor Will Not Stop Rotation	MIN Output Speed parameter set too high.	Adjust MIN Output Speed parameter value.
	Improper speed command.	Verify control is receiving proper command signal at input terminals. Verify control is set to receive your speed command.
Motor runs rough at low speed	Torque boost set too high.	Adjust torque boost parameter value.
	Misalignment of coupling.	Check motor/load coupling alignment.
	Faulty motor.	Replace with a new motor.



## TROUBLE SHOOTING GUIDE (CONT.)

INDICATION	POSSIBLE CAUSE	CORRECTIVE ACTION
New Base ID	Replaced Control or circuit board.	Restore parameters to factory settings. Reset control.
No Display	Lack of input voltage.	Check input power for proper voltage.
	Loose connections.	Check input power termination. Verify connection of operator keypad.
	Adjust display contrast.	See Adjust Display Contrast.
NV Memory Fail	Memory fault occurred.	Press "RESET" key on keypad. Restore parameter values to factory settings. If fault remains, call dealer.
3 Sec Overload	Peak output current exceeded 3 sec rating.	Check PK Current Limit parameter in the Level 2 Output Limits block. Check motor for overloading. Increase ACCEL time. Reduce motor load. Verify proper sizing of control and motor.
1 Min Overload	Peak output current exceeded 1 minute rating.	Check PK Current Limit parameter in the Level 2 Output Limits block. Check motor for overloading. Increase ACCEL/DECEL times. Reduce motor load. Verify proper sizing of control and motor.
Over Speed	Motor exceeded 110% of MAX Output Freq parameter value.	Check Max Output Freq in the Level 2 Output Limits block.
Param Checksum	Memory fault occurred.	Press "RESET" key on keypad. Restore parameter values to factory settings. If fault remains, call dealer.
Unknown Fault Code	Microprocessor detected a fault that is not defined in the fault code table.	Press "RESET" key on keypad. Restore parameter values to factory settings. If fault remains, call dealer.
Unstable Speed	Oscillating load. Unstable input power. Slip compensation too high.	Correct motor load. Correct input power. Adjust slip compensation.
uP Reset	A software watchdog timer has reset the processor because a process has timed out.	Press "RESET" key on keypad. If fault remains, call dealer.
FLT Log MEM Fail	Corrupt data in fault log (may occur on older systems only).	Press "RESET" key on keypad. If fault remains, call dealer.
Current SENS FLT	Failure to sense phase current.	Press "RESET" key on keypad. If fault remains, call dealer.
Bus Current SENS	Failure to sense bus current.	Press "RESET" key on keypad. If fault remains, call dealer.

# HOW TO ACCESS DIAGNOSTIC INFORMATION

Action	Description	Display	Comments
Apply Power			
	Display mode showing Local mode voltage, current & frequency status.	<div>STP 0V REDIFL2</div> <div>LOC 0.0 A 0.0 HZ</div>	No faults present. Local keypad mode. If in remote/serial mode, press local for this display.
Press DISP key	Scroll to fault log block.	<div>PRESS ENTER FOR</div> <div>FAULT LOG</div>	Press ENTER to view the fault log if desired.
Press DISP key	Scroll to diagnostic info block.	<div>PRESS ENTER FOR</div> <div>DIAGNOSTIC INFO</div>	Press ENTER to view diagnostic information if desired.
Press ENTER key	Access diagnostic information.	<div>STOP FREQ REF</div> <div>LOCAL 2.00 HZ</div>	
Press DISP key	Display mode showing control temperature.	<div>STOP CONTROL TEMP</div> <div>LOCAL 25.0°C</div>	Displays operating temperature in degrees C.
Press DISP key	Display mode showing bus voltage.	<div>STOP BUS VOLTAGE</div> <div>LOCAL 321V</div>	
Press DISP key	Display mode showing bus Current.	<div>STOP BUS CURRENT</div> <div>LOCAL 0.00A</div>	
Press DISP key	Display mode showing PWM Frequency.	<div>STOP PWM FREQ</div> <div>LOCAL 2497 HZ</div>	
Press DISP key	Display mode showing % overload current remaining.	<div>STOP OVRLD LEFT</div> <div>LOCAL 100.00%</div>	
Press DISP key	Display mode showing real time opto inputs & outputs states. (0=Open, 1=Closed)	<div>DIGITAL I/O</div> <div>00000000 1110</div>	Opto Inputs states (Left); Opto Outputs states (Right).
Press DISP key	Display mode showing actual drive running time since the Fault log was cleared.	<div>TIME FROM PUR UP</div> <div>0000000.01.43</div>	HR.MIN.SEC format.
Press DISP key	Display operating zone with rated hp and input voltage (for the operating zone) and control type.	<div>1 HP STD CT</div> <div>230V INVERTER</div>	
Press DISP key	Display mode showing continuous amps; PK amps rating; amps/volt scale of feedback, power base ID.	<div>XXA XXAPK</div> <div>XXA/V ID:XXX</div>	
Press DISP key	Display mode showing which Group1 or 2 expansion boards are installed.	<div>I NOT INSTALLED</div> <div>II NOT INSTALLED</div>	
Press DISP key	Display mode showing software version and revision installed in the control.	<div>SOFTWARE VERSION</div> <div>XXX-X.XX</div>	
Press DISP key	Displays exit choice. Press ENTER to exit.	<div>PRESS ENTER FOR</div> <div>DIAGNOSTIC EXIT</div>	Press ENTER to exit diagnostic information.

# HOW TO ACCESS THE FAULT LOG

When a fault condition occurs, motor operation stops and a fault code is displayed on the Keypad display. The control keeps a log of the last 31 faults. If more than 31 faults have occurred, the oldest fault will be deleted from the fault log. To access the fault log, perform the following procedure:

Action	Description	Display	Comments
Apply Power	Display mode showing Local mode voltage, current & frequency status.	<div>STP 0V REDIFL2</div> <div>LOC 0.0 A 0.0 HZ</div>	No faults present. Local keypad mode. If in remote/serial mode, press local for this display.
Press DISP key	Press DISP to scroll to the Fault Log entry point.	<div>PRESS ENTER FOR</div> <div>FAULT LOG</div>	
Press ENTER key	Display first fault type and time fault occurred.	<div>EXTERNAL TRIP</div> <div>1: 0:00:30</div>	Typical display.
Press ▲ key	Scroll through fault messages.	<div>PRESS ENTER FOR</div> <div>FAULT LOG EXIT</div>	If no messages, the fault log exit choice is displayed.
Press RESET key	Return to display mode.	<div>STOP FREQUENCY</div> <div>LOCAL 0.00 HZ</div>	Display mode stop key LED is on.

**How to Clear the Fault Log** Use the following procedure to clear the fault log.

Action	Description	Display	Comments
Apply Power	Display mode showing Local mode voltage, current & frequency status.	<div>STP 0V REDIFL2</div> <div>LOC 0.0 A 0.0 HZ</div>	Display mode.
Press DISP key	Press DISP to scroll to the Fault Log entry point.	<div>PRESS ENTER FOR</div> <div>FAULT LOG</div>	
Press ENTER key	Displays most recent message.	<div>EXTERNAL TRIP</div> <div>1: 00000:00:30</div>	
Press SHIFT key		<div>EXTERNAL TRIP</div> <div>1: 00000:00:30</div>	
Press RESET key		<div>EXTERNAL TRIP</div> <div>1: 00000:00:30</div>	
Press SHIFT key		<div>EXTERNAL TRIP</div> <div>1: 00000:00:30</div>	
Press ENTER key	Fault log is cleared.	<div>FAULT LOG</div> <div>NO FAULTS</div>	No faults in fault log.
Press ▲ or ▼ key	Scroll Fault Log Exit.	<div>PRESS ENTER FOR</div> <div>FAULT LOG EXIT</div>	
Press ENTER key	Return to display mode.	<div>PRESS ENTER FOR</div> <div>DIAGNOSTIC INFO</div>	

## FAULT MESSAGES

FAULT MESSAGE	DESCRIPTION
Invalid Base ID	Failure to determine control horsepower and input voltage configuration from the Power Base ID value in software.
NV Memory Fail	Failure to read or write to non-volatile memory.
Param Checksum	Parameter Checksum error detected.
Low INIT Bus V	Low bus voltage detected on startup.
HW Desaturation	High output current condition detected (greater than 400% of rated output current). On B2 size controls, a desat error can indicate any of the following: low line impedance, brake transistor failure or internal output transistor overtemperature.
HW Surge Current	High output current condition detected (greater than 250% of rated output current).
HW Ground Fault	Ground Fault detected (output current leakage to ground).
HW Power Supply	Control Board power supply failure detected.
Hardware Protect	A general hardware fault was detected but cannot be isolated.
1 MIN Overload	Peak output current exceeded the 1 minute rating value.
3 SEC Overload	Peak output current exceeded the 3 second rating value.
Overcurrent	Continuous current limit exceeded.
BUS Overvoltage	High DC Bus voltage.
Bus Undervoltage	Low DC Bus voltage condition detected.
Heat Sink Temp	Control heatsink exceeded upper temperature limit. For size B2 controls, this fault may indicate the main heatsink or the gate drive circuit board is too hot.
External Trip	Connection between J4-16 and J4-17 is open.
New Base ID	Control board detected a change in the Power Base ID value in software.
REGEN RES Power	Excessive power dissipation required by Dynamic Brake Hardware.
Line REGEN	Fault in Line REGEN converter unit - Series 21H Line REGEN Inverter control.
EXB Selection	Expansion board not installed to support the selected Level 1 Input Block, Command Select parameter.
Torque Proving	Unbalanced current in the three phase motor leads.
Unknown FLT Code	Microprocessor detected a fault that is not identified in the fault code table.
μP RESET	A software watchdog timer has reset the processor because a process has timed out.
FLT Log MEM Fail	Corrupt data in fault log (may occur on older systems only).
Current SENS FLT	Failure to sense phase current.
Bus Current SENS	Failure to sense bus current.

# TECHNICAL SPECIFICATIONS

DESCRIPTION	RF2	RF4
<b>Part I</b>	<b>Rated Power &amp; Markings</b>	
Input Voltage	1 X 115V +/- 10% or 1 X 230V +/- 10%	
	Single Phase Input	
Output Voltage	3 X 220V	3 X 230V
Continuous Output Current (230V input)	6.05A	8.25A
Continuous Output Current (115V input)	6.05A	6.50A
<b>Part II</b>	<b>Fundamental Parameters</b>	
Control System	PWM	
Output Voltage	Clamp @ 220V	Clamp @ 230V
Carrier Freq.	Selectable: 1-5 KHz	
Freq. Resolution	0.1Hz*	
Input Freq. Range	48 – 62 Hz	
Maximum Output Frequency(230V input)	400 Hz	100 Hz
Maximum Output Frequency(115V input)	400 Hz	80 Hz
Base Frequency	400 Hz	100 Hz
Torque Boost	0 – 15% Nominal Voltage	
V/F Pattern	Selectable Linear/Square Law	
Accel Time	0.5 – 3600 Seconds	
Decel Time	0.5 – 3600 seconds	
Accel/Decel Pattern	Linear	
<b>Part III</b>	<b>Protective Functions</b>	
Ground Fault	Ground Fault detection for Equipment Protection	
Overcurrent	Output Short Circuit Locked Rotor	
Over Voltage	400VDC	
Under Voltage	200VDC	
Motor Overload	I <sup>2</sup> x T Characteristic	
Line Start Lock Out	VFD will not start upon input power application	
Line Transient Rating	860 VAV, 810J MOV Between any power input terminal & Ground 360 VAC, 380 J MOV Between any two power input terminals	
<b>Part IV</b>	<b>Ambient Operating Conditions</b>	
Operating Temp.	-10 to 40 degree C	
Storage Temp.	-30 to 65 degree C	
Vibration	0.5G, Max / 57-150 Hz	
Elevation	3300 ft. without derating	
Max source fault current	5 Kamps	
Enclosure rating	UL Type 4, No Direct Sunlight	

## WARRANTY SERVICE

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The Redi-Flo VFD is covered by the original equipment manufacturers warranty for a period of 24 months. To obtain warranty services, contact the distributor or dealer from which it was purchased to obtain instructions. Under no circumstances should defective product be returned to the distributor, dealer, or GRUNDFOS without a return materials authorization (RMA).

## SERVICE PARTS

Only four repair parts are available, the carrying case, the keypad, power cord and Harting motor connection. Contact the dealer from which the unit was purchased for these parts.

**BE > THINK > INNOVATE >**

Being responsible is our foundation  
Thinking ahead makes it possible  
Innovation is the essence

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**North American Regional Headquarters**  
Grundfos Pumps Corporation  
17100 W. 118th Terrace  
Olathe, KS 66061  
Telephone (913) 227-3400  
Fax: (913) 227-3500

[www.grundfos.com](http://www.grundfos.com)

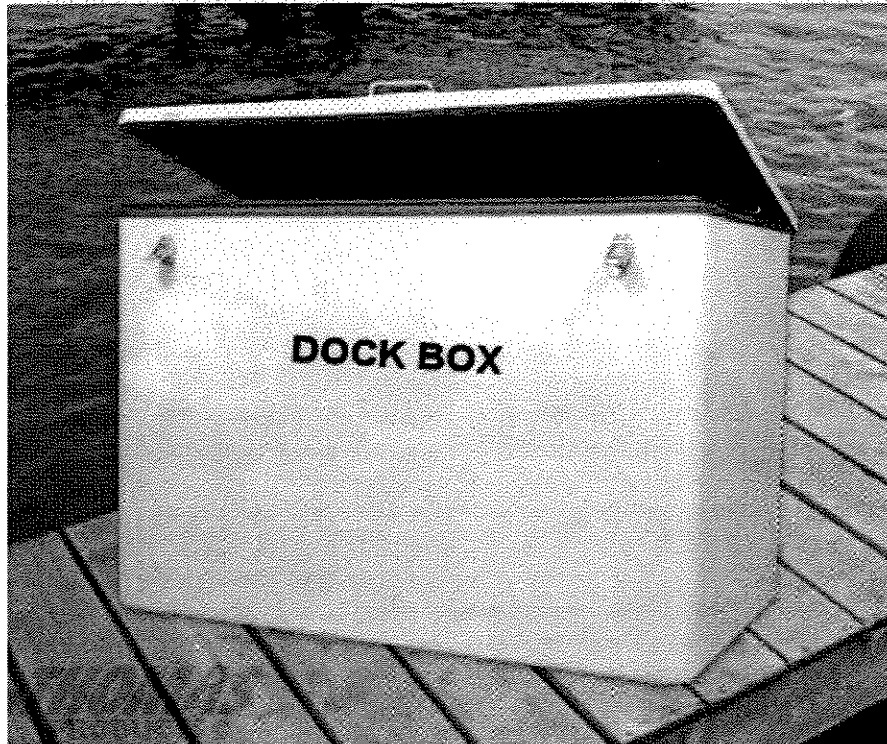
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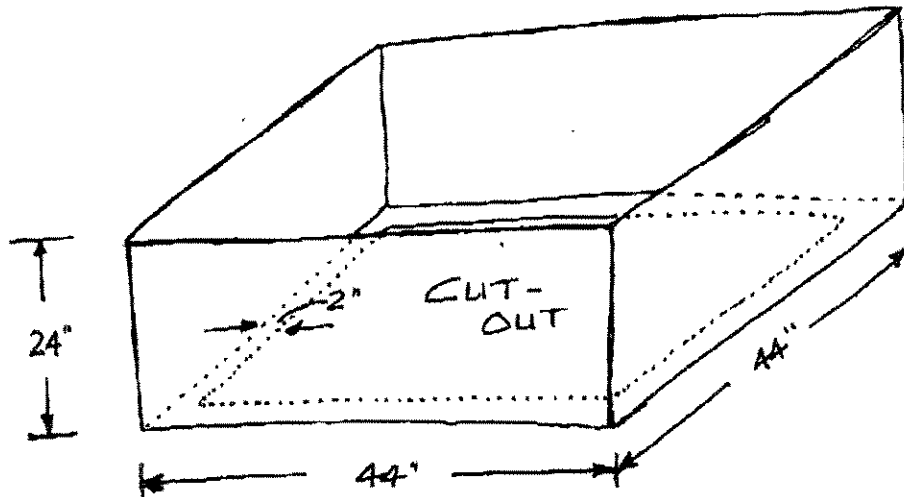
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